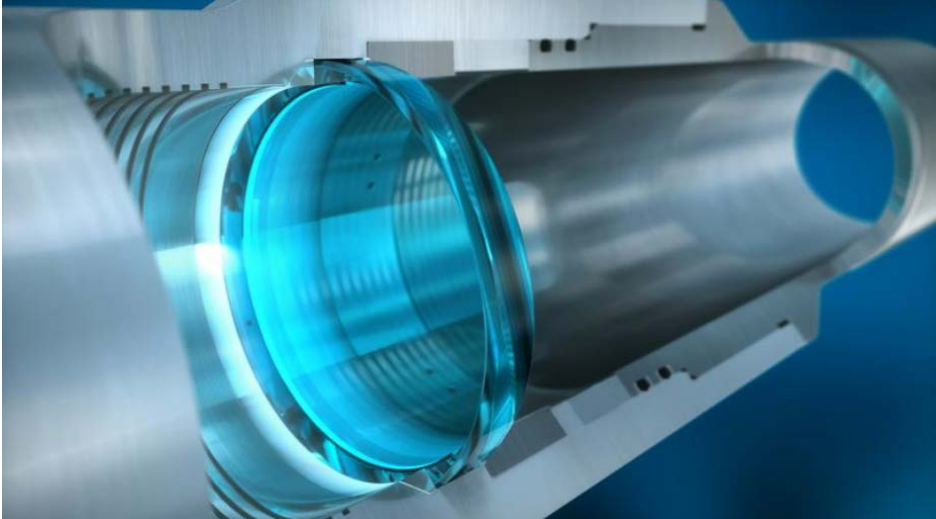




NCS's U.S. Patent No. 10,465,445 ("the '445 Patent") and the TCO TDP-PO Flotation Device

Claim 28 of the '445 Patent	TDP-PO Flotation Device ¹
<p>28.0 A float tool configured for use in positioning a casing string in a wellbore containing a well fluid, the casing string having an internal diameter that defines a fluid passageway between an upper portion of the casing string and a lower portion of the casing string, the float tool comprising:</p>	<p>TCO Group markets the following TDP-PO Flotation Device for use in a casing string placed in a wellbore:</p> 

¹ All references to the TDP-PO Flotation Device are found at <http://www.tcogroup.com/tdp-po/category52.html>; <http://www.tcogroup.com/landmarket-glass-casing-flotation-device/category112.html>; <http://www.tcogroup.com/case-studies/tco-tdp-po-pump-open-plug-eliminating-slick-line-operations-in-highly-deviated-wells-article397-72.html>.

	<p>TCO'S GLASS CASING FLOTATION DEVICE (TDP-PO)</p> <p>TCO Glass Casing Flotation Device allows operators to float casing to bottom in long laterals, even when using sliding sleeves and toe valves. Casing below the glass device is left empty allowing buoyancy to reduce friction through the lateral, while the weight of fluid above the device helps push casing to bottom. A floating casing in long laterals can remove the need to rotate casing to bottom, eliminating the need for premium casing threads.</p> <p>The Glass Casing Flotation Device is installed and run as an integrated part of the casing string. This increases the efficiency of the installation process and sets up to provide full bore access when the device is removed. The Glass Casing Flotation Device contains an internal pump open device as the primary removal option. The system is practical to operate and does not require TCO personnel on-site.</p> <p>The casing string has an internal diameter for passing fluid between an upper portion of the casing (i.e. the portion of the casing connected to the upper end of the flotation sub, shown below in green) and lower portion of the casing (the portion of the casing connected to the lower end of the flotation sub, shown below in red):</p>
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28.1	a rupture disc assembly comprising (i) a tubular member having an upper end and a lower end, the upper and lower ends configured for connection in-line with the casing string and	See element 28.0. The TDP-PO Flotation Device (i.e. a “rupture disc assembly”) is connected to the casing string. The TDP-PO Flotation Device has a tubular member that has an upper end (element 28.0 above, in green) and a lower end (element 28.0 above, in red). The upper and lower ends of the TDP-PO Flotation Device are connected in-line with the casing.
28.2	(ii) a rupture disc having a rupture burst pressure and in sealing engagement with a region of the tubular member within the upper and lower ends	As shown below, the TDP-PO Flotation Device (i.e. “rupture disc assembly”) includes a glass barrier (i.e., a “rupture disc,” below in blue). This barrier is in sealing engagement with the inner walls of the TDP-PO Flotation Device:

		
28.3	<p>wherein the rupture disc is configured to disengage from sealing engagement when exposed to a pressure greater than a hydraulic pressure in the casing string after the casing string has been positioned in the wellbore</p>	<p><i>See</i> element 28.0 and 28.2. The rupture disc disengages from the sealing engagement when it is exposed to a pressure that is greater than the hydraulic pressure in the casing string:</p> <p>Glass material Our patented laminated glass material provides a secure, non-corrodible seal under high temperature and axial loads, capable of withholding extreme levels of differential pressure from below. The glass material breaks into small particles which can be safely circulated through sleeves, toe valves, and float equipment. No debris trap required.</p>

		<p>The TDP-PO does not require pressure communication all the way down to the actual barrier mechanism to remote open. The plug is opened at a predetermined differential pressure over the barrier device. Having debris settled on top of the plug will not affect the opening as long as the force generated</p> <p>by the applied pressure reaches the breaking mechanism. A test was conducted to prove the debris tolerance by settling 8 feet of debris on top of the plug prior to opening. The debris had no effect on the opening pressure.</p>
28.4	and the region of the tubular member where the rupture disc is attached has a larger internal diameter than the internal diameter of the casing string and is parallel to the internal diameter of the casing string.	<p>The TDP-PO Flotation Device glass barrier (i.e. “rupture disc”) (<i>see</i> element 28.2) is positioned in a region of the TDP-PO Flotation Device that has a larger internal diameter (below in gold) than the internal diameter of the casing string (below in pink), and is parallel to the internal diameter of the casing string:</p> 